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DICKSTEIN SHAPIRO LLP 1177 AVENUE OF THE AMERICAS (6TH AVENUE) NEW YORK, NY 10036-2714			MAYES, MELVIN C	
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**BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES**

MAILED

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GROUP 1700

Application Number: 10/624,537

Filing Date: July 23, 2003

Appellant(s): HORIKAWA ET AL.

Edward A. Meilman
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed June 6, 2007 appealing from the Office action mailed August 9, 2006.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

No amendment after final has been filed.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

6,080,328	HORIKAWA	6-2000
2004/0012000	PONOMAREV ET AL.	1-2004
6,383,408	HORIKAWA ET AL.	5-2002
2002/0098333	FELTZ ET AL.	7-2002
6,280,650	OGAWA ET AL.	8-2001
2001/0045792	TAKESHIMA	11-2001
JP 2-122511	HOSHI	5-1990
JP 2001-181035	NANAO ET AL.	7-2001

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

(A)

Claims 1, 4, 5, 7-9, 11 and 14-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Horikawa 6,080,328 in view of Ponomarev et al. 2004/0012000, Horikawa et al. 6,383,408 and JP 2-122511.

Horikawa '328 discloses a method of making a piezoelectric ceramic element comprising: providing a piezoelectric ceramic of the formula $Pb_a[(Cr_xNb_{(1-x)})_yZr_{(1-b-y)}Ti_b]O_3$, wherein $0.95 \leq a \leq 1.05$; producing green sheets; laminating green sheets with internal electrodes;

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and firing. Green sheets of thickness of 60-100 um can be coated with electrode paste of Ag/Pd of ratio 7/3 (col. 2, lines 39-67, col. 8, lines 5-35). Horikawa does not disclose limiting the Pb in the composition to molar quantity reduced by 0.5-5 mol% from that of stoichiometric composition or disclose firing (sintering) in an atmosphere of oxygen concentration of 5 vol% or less but more than 0 vol%.

Ponomarev et al. teach that to achieve high efficiency under dynamic operations such as in a multilayer piezoelectric ceramic transformer, low-loss hard piezoelectric ceramic materials are required [0002].

Horikawa et al. teach that a piezoelectric ceramic which has significantly low loss is a composition represented by the formula $Pb_x\{(Mn_aNb_b)_yTi_zZr_{(1-y-z)}\}O_3$, where on a molar basis $0.95 \leq x \leq 0.995$ (col. 2, lines 44-56). When the amount of Pb is decreased below stoichiometric content, no foreign phase exist in the sintered material, and hence a piezoelectric ceramic having an even lower loss can be obtained (col. 3, lines 14-18)

JP 2-122511 (JP '511) teaches that a laminate of green sheets and Ag-Pd paste inner electrodes is calcined (sintered) in a low oxygen concentration environment of less than 50,000 ppm oxygen to improve reliability and reduce costs while retaining needed characteristics.

It would have been obvious to one of ordinary skill in the art to have modified the method of Horikawa '328 for making a piezoelectric ceramic element by limiting the limiting the Pb in the composition to molar quantity reduced by 0.5-5 mol% ($0.95 \leq a \leq 0.995$) from that of stoichiometric composition, as Horikawa et al. teach that such a composition has low loss because of Pb content decreased below stoichiometric content and as Ponomarev et al. teach that

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low loss is desired for multilayer piezoelectric ceramic elements. Limiting the Pb molar quantity as claimed would have been obvious to one of ordinary skill in the art to achieve lower loss, taught by Ponomarev et al. as desired for multilayer piezoelectric ceramic elements.

It would have been obvious to one of ordinary skill in the art to have further modified the method of Horikawa '328 by firing (sintering) the laminate in a low oxygen atmosphere of less than 50,000 ppm oxygen, as taught by JP '511, as used to sinter a laminate of green sheets and Ag-Pd electrodes to improve reliability and reduce costs while retaining needed characteristics. Sintering in an oxygen atmosphere of oxygen concentration in the range of up to 5 vol%, as claimed, would have been obvious to one of ordinary skill in the art as encompassed by the range of less than 50,000 ppm oxygen taught by JP '511.

By providing the piezoelectric ceramic of composition $Pb_a[(Cr_xNb_{(1-x)})_yZr_{(1-b-y)}Ti_b]O_3$, the average valence of the B site component is greater than stoichiometric and greater than 4.000 but less than 4.100, as claimed and the B site component comprises Nb and Cr, as claimed in Claims 5, 7, 8 and 15.

(B)

Claims 6 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Horikawa 6,080,328 in view of Ponomarev et al. 2004/0012000, Horikawa et al. 6,383,408 and JP 2-122511 as applied to claims 1 or 4, and further in view of Feltz et al. 2002/0098333.

Feltz et al. teach that in piezoelectric ceramic, partial substitution of the quadrivalent cations Zr and Ti on the B-positions can be by a combination of two-valent metal cations such as Ni and quinvalent metal cations such as Nb [0020].

It would have been obvious to one of ordinary skill in the art to have further provided Ni in addition to the Nb, as taught by Feltz et al., as metal cation that can be provided with Nb for partial substitution of Zr and Ti in piezoelectric ceramic. Providing Nb and Ni as part of the B-site component in partial substitution of Zr and Ti would have been obvious to one of ordinary skill in the art, as taught by Feltz et al.

(C)

Claims 12 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Horikawa 6,080,328 in view of Ponomarev et al. 2004/0012000, Horikawa et al. 6,383,408 and JP 2-122511 as applied to claim 11, and further in view of JP 2001-181035.

Horikawa '328 discloses firing at a temperature of 1100°C or less.

JP '035 teaches that in making a piezoelectric ceramic transducer, etc, if the burning temperature is made low, it is possible to use cheaper silver-palladium alloy as the internal electrode. To lower manufacturing cost, it is desirable to make the percentage of palladium be 20% or less, which can be used with a burning temperature of 1000°C or less (computer translation [0004]).

It would have been obvious to one of ordinary skill in the art to have modified the method of the references as combined by coating the green sheets with Ag/Pd paste of at least 80% or 85% Ag, as taught by JP '035, to lower manufacturing costs by using cheaper Ag/Pd alloy. The use of an Ag/Pd paste of ratio of at least 80/20 or 85/15 would have been obvious to one of ordinary skill in the art to lower the manufacturing cost by using a cheaper Ag/Pd alloy.

By producing green sheets of thickness of 60-100 um, piezoelectric layers of thickness less than 64 um or 40 um after sintering are obviously provided.

(D)

Claims 22-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Horikawa 6,080,328 in view of Ponomarev et al. 2004/0012000, Horikawa et al. 6,383,408 and JP 2-122511, further in view of either Ogawa et al. 6,280,650 or Takeshima 2001/0045792.

Horikawa '328 discloses a method of making a piezoelectric ceramic element comprising: providing a piezoelectric ceramic of the formula $Pb_a[(Cr_xNb_{(1-x)})_yZr_{(1-b-y)}Ti_b]O_3$, wherein $0.95 \leq a \leq 1.05$; producing green sheets; laminating green sheets with internal electrodes; and firing. Green sheets of thickness of 60-100 μm can be coated with electrode paste of Ag/Pd of ratio 7/3 (col. 2, lines 39-67, col. 8, lines 5-35). Horikawa does not disclose limiting the Pb in the composition to molar quantity reduced by 0.5-5 mol% from that of stoichiometric composition or disclose firing (sintering) in an atmosphere of oxygen concentration of 5 vol% or less but more than 0 vol%.

Ponomarev et al. teach that to achieve high efficiency under dynamic operations such as in a multilayer piezoelectric ceramic transformer, low-loss hard piezoelectric ceramic materials are required [0002].

Horikawa et al. teach that a piezoelectric ceramic which has significantly low loss is a composition represented by the formula $Pb_x\{(Mn_aNb_b)_yTi_zZr_{(1-y-z)}\}O_3$, where on a molar basis $0.95 \leq x \leq 0.995$ (col. 2, lines 44-56). When the amount of Pb is decreased below stoichiometric content, no foreign phase exist in the sintered material, and hence a piezoelectric ceramic having an even lower loss can be obtained (col. 3, lines 14-18)

JP 2-122511 (JP '511) teaches that a laminate of green sheets and Ag-Pd paste inner electrodes is calcined (sintered) in a low oxygen concentration environment of less than 50,000 ppm oxygen to improve reliability and reduce costs while retaining needed characteristics.

Ogawa et al. and Takeshima each teach that one type of piezoelectric device formed using piezoelectric ceramic and electrodes is a piezoelectric buzzer (col. 1).

It would have been obvious to one of ordinary skill in the art to have modified the method of Horikawa '328 for making a piezoelectric ceramic element by limiting the limiting the Pb in the composition to molar quantity reduced by 0.5-5 mol% ($0.95 \leq a \leq 0.995$) from that of stoichiometric composition, as Horikawa et al. teach that such a composition has low loss because of Pb content decreased below stoichiometric content and as Ponomarev et al. teach that low loss is desired for multilayer piezoelectric ceramic elements. Limiting the Pb molar quantity as claimed would have been obvious to one of ordinary skill in the art to achieve lower loss, taught by Ponomarev et al. as desired for multilayer piezoelectric ceramic elements.

It would have been obvious to one of ordinary skill in the art to have further modified the method of Horikawa '328 by firing (sintering) the laminate in a low oxygen atmosphere of less than 50,000 ppm oxygen, as taught by JP '511, as used to sinter a laminate of green sheets and Ag-Pd electrodes to improve reliability and reduce costs while retaining needed characteristics. Sintering in an oxygen atmosphere of oxygen concentration in the range of up to 5 vol%, as claimed, would have been obvious to one of ordinary skill in the art as encompassed by the range of less than 50,000 ppm oxygen taught by JP '511.

Using the method of the references as combined to make a piezoelectric element used as a piezoelectric buzzer (audio emitter part) would have been obvious to one of ordinary skill in

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the art, as taught by Ogawa et al. or Takeshima, as one type of piezoelectric device made using piezoelectric ceramic and electrodes.

By providing the piezoelectric ceramic of composition $Pb_a[(Cr_xNb_{(1-x)})_yZr_{(1-b-y)}Ti_b]O_3$, the average valence of the B site component is greater than stoichiometric and greater than 4.000 but less than 4.100, as claimed and the B site component comprises Nb, as claimed in Claim 24.

(E)

Claim 27 is rejected under 35 U.S.C. 103(a) as being unpatentable over Horikawa 6,080,328 in view of Ponomarev et al. 2004/0012000, Horikawa et al. 6,383,408 and JP 2-122511, further in view of either Ogawa et al. 6,280,650 or Takeshima 2001/0045792 as applied to claim 22, and further in view of JP 2001-181035.

Horikawa '328 discloses firing at a temperature of 1100°C or less.

JP '035 teaches that in making a piezoelectric ceramic transducer, etc, if the burning temperature is made low, it is possible to use cheaper silver-palladium alloy as the internal electrode. To lower manufacturing cost, it is desirable to make the percentage of palladium be 20% or less, which can be used with a burning temperature of 1000°C or less (computer translation [0004]).

It would have been obvious to one of ordinary skill in the art to have modified the method of the references as combined by coating the green sheets with Ag/Pd paste of 80% or 85% Ag, as taught by JP '035, to lower manufacturing costs by using cheaper Ag/Pd alloy. The use of an Ag/Pd paste of ratio of at least 80/20 would have been obvious to one of ordinary skill in the art to lower the manufacturing cost by using a cheaper Ag/Pd alloy.

By producing green sheets of thickness of 60-100 μm , piezoelectric layers of thickness less than 64 μm after sintering are obviously provided.

(10) Response to Argument

(A)

Appellant argues that the combination of Horikawa '328, Ponomarev and Horikawa '408 fails to teach or suggest that piezoelectric parts can be fabricated without deteriorating the piezoelectric d constant, a surprising and unexpected result, by cosintering ceramic layers and internal electrode layers in an atmosphere where the oxygen concentration is a positive amount of up to about 5 volume percent, if the molar quantity of the A site of the perovskite has been reduced by about 0.5 to 5 mole percent from stoichiometric amount, and the average valence of the B site component is increased to greater than 4 but less than 4.1. Appellant argues that Horikawa '408 does not teach or suggest cofiring a green piezoelectric ceramic body which has internal electrodes under any conditions or firing in a reduced oxygen atmosphere. Appellant argues that JP 2-122511 (JP '511) does not obviate this deficiency because JP '511 concerns a ceramic capacitor made by sintering in a low oxygen atmosphere, which are dielectric ceramics, not piezoelectric ceramics. Appellant argues that the crystal structure of a dielectric as in JP '511 is very different from that of a perovskite piezoelectric as in the other references and argues that there is no reason or motivation to extract some part of the teachings of JP '511 and utilize it in the PZT piezoelectric ceramics of the other references and argues that the reliance on JP '511 is based on hindsight.

Appellant argues that the rejection seeks to ignore other art of record in this case which establishes that those skilled in the art would expect a lead perovskite piezoelectric ceramic material with internal electrodes to have deteriorated piezoelectric d constant when sintered in a reduced oxygen atmosphere.

Horikawa '328 disclose providing a piezoelectric ceramic of the formula $Pb_a[(Cr_xNb_{(1-x)})yZr_{(1-b-y)}Ti_b]O_3$, wherein $0.95 \leq a \leq 1.05$, thus discloses using a composition in which the molar quantity of the A site component Pb can be as low as 0.95 (A site component reduced by up to 5 mol%), and cofiring (sintering) with Ag/Pd internal electrodes to form a piezoelectric ceramic element. Horikawa et al. '408 is pertinent because it suggests to limit the A site component Pb in the composition to molar quantity reduced by 0.5-5 mol% from that of stoichiometric composition so that no foreign phase exist in the sintered material, and hence a piezoelectric ceramic having an even lower loss can be obtained, low loss required to achieve high efficiency under dynamic operations, as suggested by Ponomarev et al. These teachings would have suggested to one of ordinary skill in the art to limit the molar quantity of Pb (A site component) in the formula of Horikawa '328 to reduced by 0.5-5 mol% from that of stoichiometric composition, as claimed by Appellant, for lower loss, thus achieving high efficiency under dynamic conditions.

While Horikawa et al. '408 does not teach or suggest cofiring ceramic and internal electrodes, this is clearly disclosed by the primary reference Horikawa '328. The Examiner's position is that the teaching of Horikawa et al. '408 to limit Pb in the composition to molar quantity reduced by 0.5-5 mol% from that of stoichiometric composition so that no foreign phase

exist in the sintered material is just as relevant to a method involving sintering a piezoelectric ceramic with internal electrodes, as in the method of Horikawa '328. The teaching of Horikawa et al. '408 is pertinent to piezoelectric ceramic in general and not the particular method in which piezoelectric ceramic is sintered with electrode material.

With respect to co-firing (sintering) the piezoelectric ceramic and Ag/Pd internal electrodes in a reduced oxygen atmosphere, JP 2-122511 (JP '511) is clearly pertinent. Horikawa '328 discloses sintering the piezoelectric ceramic with Ag/Pd inner electrode paste but does not disclose the particular atmosphere used during sintering. JP '511 suggests to sinter a laminate of green sheets and Ag-Pd paste inner electrodes in a low oxygen concentration environment of less than 50,000 ppm oxygen in order to improve reliability and reduce costs while retaining needed characteristics. According to JP '511 when an electroconductive paste containing Ag is baked in an atmosphere with an oxygen density sufficiently lower than that of normal atmosphere, specifically oxygen density of 50,000 ppm or less, the activity of the Ag is reduced and during baking the degree of diffusion of the Ag into the ceramic can be sufficiently suppressed (translation, page 6, fourth paragraph). Such an atmosphere is within Appellant's claimed ranged of "oxygen concentration is about 5% by volume or less but more than 0% by volume.

The Examiner's position is that it would have been obvious to one of ordinary skill in the art to have further modified the method of Horikawa '328 by firing (sintering) the laminate of piezoelectric green sheet and Ag/Pd inner electrode paste in a low oxygen atmosphere of less than 50,000 ppm oxygen, as taught by JP '511, to improve reliability and reduce costs while retaining needed characteristics. Appellant's arguments that JP '511 concerns a ceramic

capacitor made by sintering in a low oxygen atmosphere, which are dielectric ceramics and not piezoelectric ceramics and that the crystal structure of a dielectric as in JP '511 is very different from that of a perovskite piezoelectric as in the other references are not convincing. Although JP '511 does discuss the benefit of sintering Ag/Pd paste in the atmosphere in terms of making a laminate ceramic capacitor, the Examiner's position is that the teaching also pertinent to co-firing a piezoelectric ceramic with Ag/Pd paste. Suppressing diffusion of Ag into the ceramic during firing as taught by JP '511 is just as relevant to making a laminate with piezoelectric ceramic material as with a dielectric ceramic material.

With respect to other art of record in this case, the Randall 2002/0079622 reference of record in this case is directed to co-firing piezoelectric ceramic material with base metals such as copper, not noble metals such as Ag and Pd. The Watanabe reference (JP 11-163433) reinforces that there is a diffusion problem when sintering with Ag internal electrodes and teaches sintering in an atmosphere of low oxygen concentration.

(B)

With respect to the rejection of Claims 6 and 21 based on Horikawa 6,080,328 in view of Ponomarev et al. 2004/0012000, Horikawa et al. 6,383,408 and JP 2-122511 as applied to claims 1 or 4, and further in view of Feltz et al. 2002/0098333, Appellant has present no further arguments.

(C)

With respect to the rejection of Claims 12 and 13 based on Horikawa 6,080,328 in view of Ponomarev et al. 2004/0012000, Horikawa et al. 6,383,408 and JP 2-122511 as applied to claim 11, and further in view of JP 2001-181035, Appellant has present no further arguments.

(D)

With respect to the rejection of Claims 22-26 based on Horikawa 6,080,328 in view of Ponomarev et al. 2004/0012000, Horikawa et al. 6,383,408 and JP 2-122511, further in view of either Ogawa et al. 6,280,650 or Takeshima 2001/0045792, Appellant has present no further arguments.

(E)

With respect to the rejection of Claim 27 based on Horikawa 6,080,328 in view of Ponomarev et al. 2004/0012000, Horikawa et al. 6,383,408 and JP 2-122511, further in view of either Ogawa et al. 6,280,650 or Takeshima 2001/0045792 as applied to claim 22, and further in view of JP 2001-181035, Appellant has present no further arguments.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,



Melvin C. Mayes

Conferees:

/Jennifer Michener/

Quality Assurance Specialist, TC1700

/Christopher A. Fiorilla/

Christopher Fiorilla

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